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Improving Irrigation Water Quality for Crop Health

Justin Leavitt

Moleaer Inc., 3232 W El Segundo Blvd, Hawthorne, California 90250 USA

Justin@moleaer.com

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Summary

Water quality is a crucial factor in achieving optimal farm and crop health, yet rigorous and frequent testing is often overlooked as a priority. High-quality water can enhance plant health and productivity, while poor water quality can harbor pathogens and create conditions conducive to crop disease, uneven irrigation and loss of crops. This paper explores the importance of monitoring key water quality metrics such as dissolved oxygen (DO), oxidation-reduction potential (ORP), and pathogen levels - discussing the challenges of maintaining these parameters and the importance of prioritizing regular, comprehensive testing. By leveraging advanced oxygenation technology, growers can address water quality challenges with precision. Through targeted water quality improvements and proactive testing, growers can enhance crop health, reduce risks, and optimize resource use. Moleaer's role in providing efficient oxygenation technology is also discussed, emphasizing the benefits of oxygen-rich water in reducing pathogens and promoting healthier crop growth.

INTRODUCTION

Water is the most essential resource used in farming. Yet the quality and testing of irrigation water is often not prioritized. It is not just a question of water scarcity, but also water's ability to support plant health and growth. Poor-quality water can introduce harmful pathogens, such as *Pythium* and other water-borne pathogens, creating a domino effect of negative impacts on crop yield and farm efficiency. This paper delves into the importance of water quality, understanding the metrics that matter, and methods to use that improve water quality for the benefit of crops. Technological advancements, such as the use of nanobubbles to increase oxygen levels in water, provide additional tools to improve water conditions. By prioritizing water quality, growers can gain insights into what is happening within their irrigation systems and make informed decisions to safeguard their crops.

WHY WATER QUALITY MATTERS

Water quality plays a pivotal role in determining overall crop health. While many growers focus on water availability, the importance of water quality in supporting plant growth and minimizing disease is often overlooked. High-quality water can create an environment that promotes healthy root systems and nutrient absorption while poor-quality water can introduce pathogens, inhibit plant growth, and contribute to system inefficiencies like clogged irrigation emitters. Additionally, oxygen-rich water promotes aerobic conditions that suppress harmful pathogens, ensuring healthier root development and plant growth. Algae and biofilm buildup can reduce irrigation uniformity, leading to uneven water distribution and poor crop performance. Addressing water quality is not just about preventing these issues but also about creating a foundation for long-term success that results in healthier crops and higher yields.

KEY WATER QUALITY METRICS

While algae is often favored as an indicator of water body health, it does not sufficiently capture what's really going on – some healthy water bodies have algae. There are three primary water quality metrics that every farm should regularly test and monitor: Dissolved oxygen (DO), oxidation-reduction potential (ORP), and pathogen levels. Together, these provide comprehensive insights into the health of the water source and its ability to support optimal crop growth.

Dissolved Oxygen (DO): DO is critical for promoting aerobic conditions that suppress harmful anaerobic pathogens such as Pythium. Low DO levels can stunt plant growth and increase susceptibility to diseases. Water with DO levels below 5 parts per million (ppm) is considered unacceptable, while levels between 7-9 ppm are acceptable, and 9-18 ppm is excellent. High DO levels promote healthy root development and reduce the risk of overwatering.

Oxidation-Reduction Potential (ORP): ORP measures a water source's ability to cleanse itself through oxidation, with higher ORP levels indicating a reduced risk of pathogen growth. In irrigation systems, ORP values above 300 millivolts (mV) are ideal, as they indicate a water environment that is hostile to pathogens and supports more efficient nutrient absorption.

Pathogen Testing: Testing for bacterial and fungal pathogens is essential for understanding the health risks present in irrigation water. Total Colony Forming Units (CFU) for bacteria and fungi provide a snapshot of microbial communities in the water, helping growers identify potential threats before they reach their crops. Regular pathogen testing at both the water source and at the end of irrigation systems ensures that water treatment strategies are effective.

IMPROVING WATER QUALITY

Maintaining high water quality requires proactive management and regular testing. Growers can take several steps to improve their irrigation water, starting with addressing biofilm and algae buildup. Filtration systems can help reduce clogging in emitters, while oxygenation treatments can improve overall water quality by shifting microbial communities from anaerobic to aerobic.

Oxygenation, specifically, can be a game-changer for irrigation systems. By increasing DO levels, growers can reduce pathogen loads, promote healthier plant growth, and improve irrigation efficiency. Moleaer's nanobubble technology is a solution for boosting DO levels and transforming water quality across the system. A study conducted by Biosabor in collaboration with Agrocolor FL https://www.agrocolor.de/ examined the impact of nanobubble-enriched irrigation water on greenhouse tomatoes cultivated in native soil. The research involved comparing tomato crops irrigated with nanobubble-enriched water against those using untreated water. The findings demonstrated that the use of nanobubbles not only elevated dissolved oxygen levels but also enhanced the overall quality and yield of crops. Specifically, the nanobubble-enriched irrigation water exhibited a higher and more stable DO concentration averaging 20.8 ppm, compared to 6.3 ppm in the control group **(Figs. 1 and 2)**.

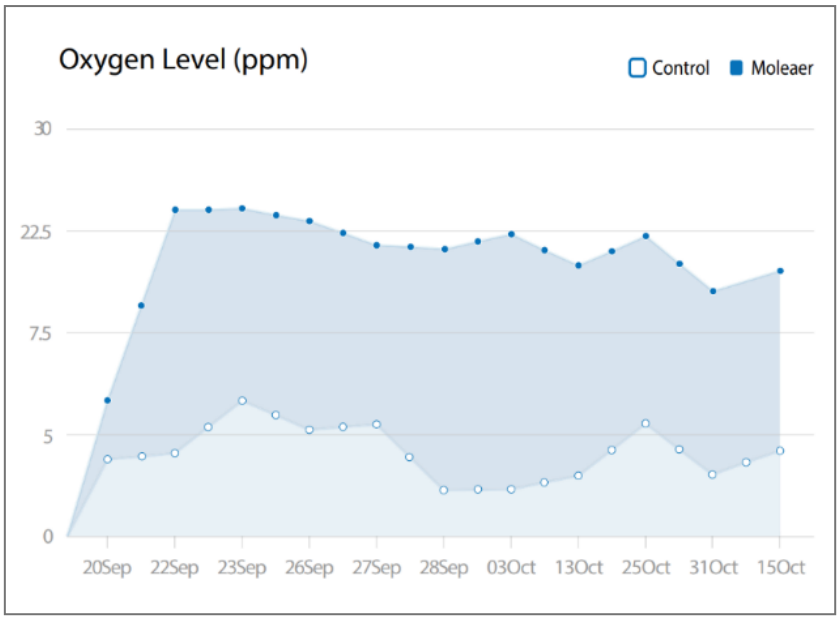

Figure 1: Tomatoes increased yield by 9.7% with nanobubble-Enriched irrigation and saw over 200% increase in dissolved oxygen (Moleaer, 2022a).

Figure 2. Biosabor, a distributor of Moleaer's nanobubble technology in Spain, together with Agrocolor SL, studied the effects of nanobubble-enriched irrigation water on greenhouse tomatoes grown in native soil. Oxygen nanobubbles improved crop yield by creating better root zone conditions for more robust root development. https://www.moleaer.com/resources/case-study-biosabor-tomatoes

THE ROLE OF OXYGEN IN WATER QUALITY

Oxygen plays a critical role in water management, particularly in determining whether a water environment is conducive to pathogen growth. Lower oxygen levels promote anaerobic conditions, leading to an increase in harmful bacteria and fungi. Conversely, increasing oxygen levels creates an aerobic environment that supports beneficial microbial communities and reduces the risk of disease.

Aardbeienkwekerij Penninx, a strawberry nursery in the Netherlands, https://www.chielkesaardbeien.nl/ implemented a trial with Moleaer's nanobubble technology to address organic contamination in their irrigation system. Before the treatment, the nursery faced challenges, particularly during early spring and summer, when stagnant water led to increased organic contamination. After introducing nanobubble-enriched water, measurements showed significantly higher dissolved oxygen (DO) levels in both the irrigation water tank and drip lines, enhancing plant resilience against diseases and improving nutrient uptake. Notably, levels of harmful pathogens like *Pythium* and *Phytophthora* were reduced, and biofilm contamination in the water system diminished, resulting in visibly clearer water and healthier substrate conditions **(Fig. 3)**.

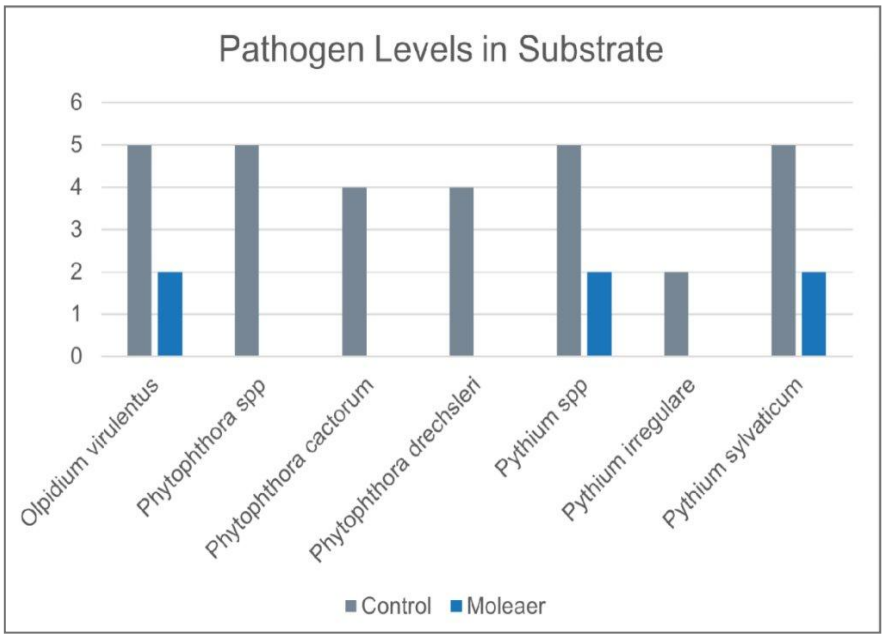

Figure 3: Pathogen levels were rated on a scale of 1-6, 1 being the lowest concentration and 6 the highest. There was a significant reduction in *Pythium* and *Phytophthora* (Moleaer, 2022b).

PATHOGEN REDUCTION AND IRRIGATION WATER

Waterborne pathogens are a significant challenge in agriculture, especially as water temperatures rise and pathogen counts increase in irrigation ponds. By improving water quality through oxygenation and ORP management, growers can reduce the pathogen load in their irrigation systems, making fungicides more effective and protecting crops from diseases.

Regular testing of both pathogen levels and water quality metrics are key to identifying and addressing potential issues before they impact crop health. By testing at both the source and at the end of irrigation lines, growers can ensure that their water is free from harmful pathogens throughout the entire irrigation process.

UNPACKING THE SCIENCE OF NANOBUBBLE TECHNOLOGY

Nanobubbles are incredibly tiny gas bubbles, measuring less than 2,500 times smaller than the size of a grain of salt **(Fig. 4)**. Due to their minuscule size and significantly lower buoyancy compared to ordinary bubbles, they remain suspended in water for extended periods **(Fig. 5)** This unique property allows nanobubbles to alter the physical characteristics of water, creating a reservoir of entrained oxygen. In fact, nanobubbles can increase dissolved oxygen (DO) levels by up to 20% beyond the normal gas saturation point, resulting in more stable oxygen levels over time.

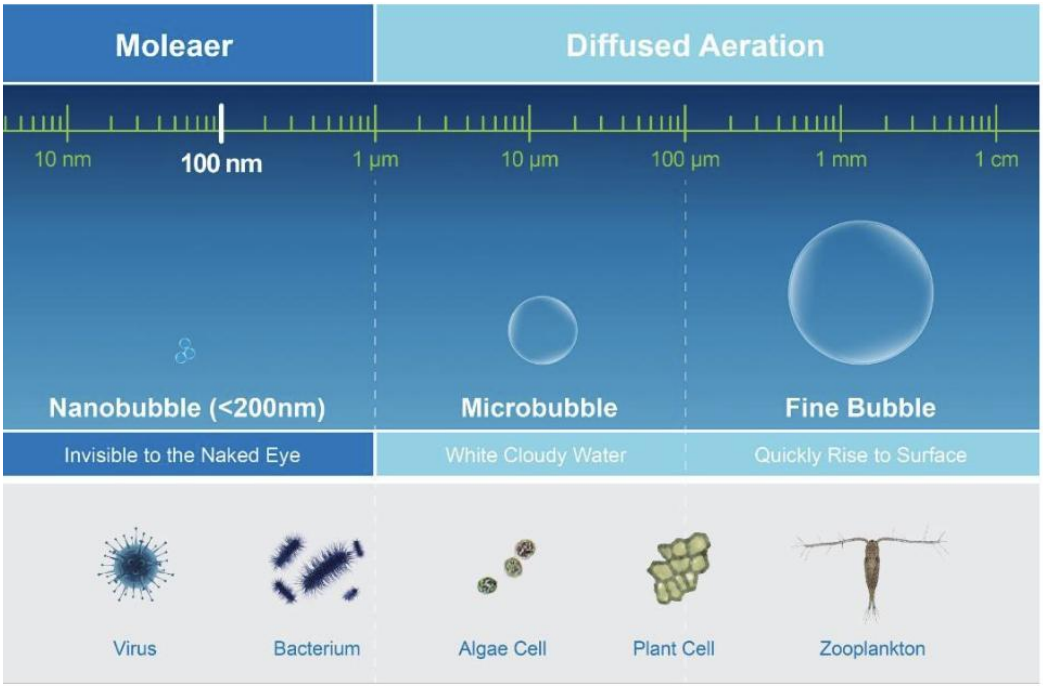

Figure 4: Nanobubbles are not visible to the naked eye and are about the size of a virus or small bacteria. They are 2,500x smaller than a grain of salt.

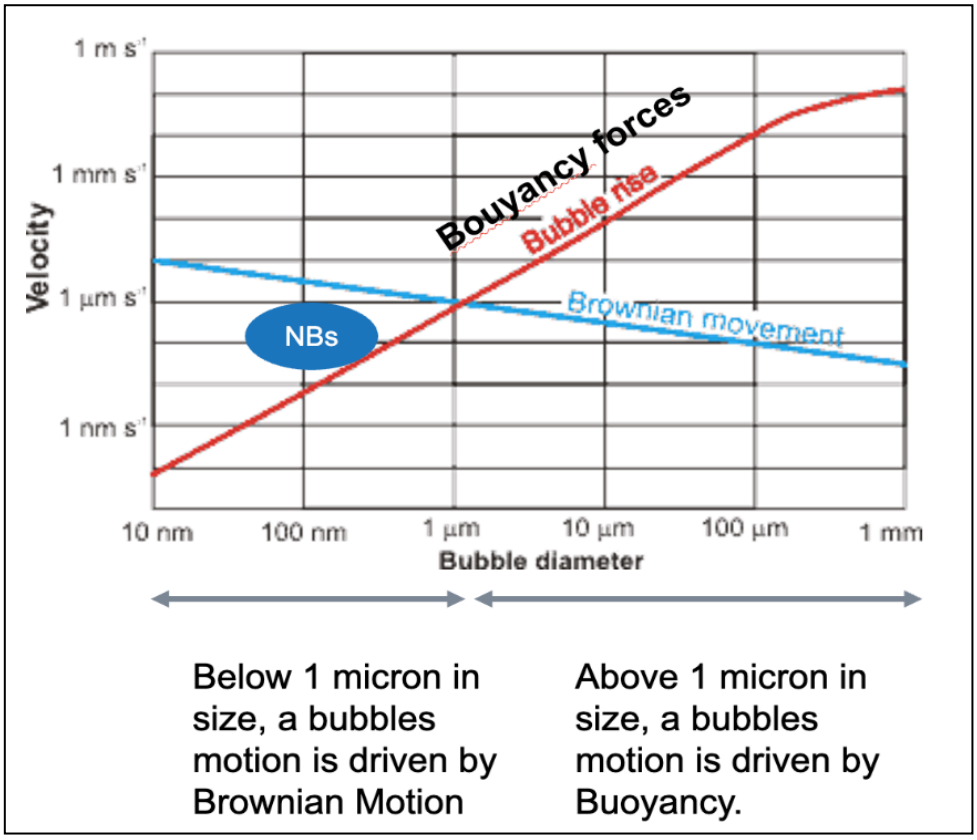

Figure 5. The Forces of Brownian Motion are stronger than buoyancy - so nanobubbles do not rise to the liquid surface.

Additionally, nanobubbles create conditions that reduce the growth of pathogens and algae. That is, nanobubbles significantly increase DO and the ORP of irrigation water, which suppresses pathogen growth while promoting the growth of beneficial microbes such as mycorrhizae. In independent testing, Moleaer technology was found to provide the highest proven oxygen transfer rate in the aeration/gas infusion industry (Dr. Michael Stenstrom, University of California-Los Angeles).

Moleaer's nanobubble technology harnesses this efficiency to deliver superior gas-to-liquid transfer, injecting trillions of nanobubbles into water. This process not only replaces energy-intensive gas transfer methods but also eliminates the need for harmful chemical oxidants and surfactants. The chemical-free and energy-efficient nature of nanobubble technology makes it an ideal solution for improving water quality, reducing biofilm buildup, and preventing clogging in irrigation systems. By incorporating nanobubbles, growers can optimize water conditions to promote healthier crops.

With a hard, stable surface, nanobubbles naturally scour biofilm and scale from irrigation systems to keep surfaces clean and reduce pathogenic growth. The natural oxidation capacity of nanobubbles also degrades biofilm and prevents its buildup. As mentioned, biofilm is pervasive on most surfaces in frequent contact with water and acts as a potential refuge for a wide range of plant root pathogens. For example, scientists at the University of California and China Agricultural University recently found that nanobubbles effectively control biofouling in irrigation pipelines.

They are "detrimental to the mutualistic interactions among microbial species, destabilizing the [molecular ecological] network complexity and size…decreasing extracellular polymers and biofilm biomass."

CONCLUSION

Improving irrigation water quality is essential for optimizing crop health, enhancing productivity, and mitigating risks associated with pathogens. The ability to measure and manage critical water quality metrics, such as dissolved oxygen (DO), oxidation-reduction potential (ORP), and pathogen levels, is key to maintaining a healthy growing environment. By embracing advanced oxygenation technologies, like Moleaer's nanobubble technology, growers can create an oxygen-rich water environment that not only promotes healthier root development but also inhibits harmful pathogens and reduces biofilm buildup in irrigation systems.

Incorporating regular and comprehensive water testing allows producers to identify potential issues early and take corrective action before they impact crop performance. The benefits of improving water quality are twofold: growers can reduce reliance on chemical treatments while simultaneously boosting the overall efficiency of their irrigation systems. Nanobubbles, with their ability to deliver higher levels of dissolved oxygen and improve ORP, represent a significant advancement in water treatment, offering a chemical-free, energy-efficient solution to long-standing agricultural challenges.

Ultimately, the health of the crops is intricately linked to the quality of the water they receive. By prioritizing water quality improvements, growers can increase yields, reduce the risks of disease, and ensure long-term sustainability in their farming operations. Through the adoption of cutting-edge technologies, the agricultural industry can continue to advance toward a future of more resilient and productive farming practices.

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